Semester 1 Examinations 2016/ 2017

Exam Code(s)	4BCT, 4th Year B.Sc. (CS&IT)
Exam(s)	
Module Code(s)	CT404
Module(s)	Graphics and Image Processing
Paper No.	
Repeat Paper	
External Examiner(s)	Prof. L. Maguire Dr. J. Power
Internal Examiner(s)	Dr. J. Duggan * Dr. S. Redfern

***Instructions*:** Answer any three questions.
All questions carry equal marks.

Duration	2 hours
No. of Pages	6
Discipline(s)	Information Technology
Course Co-ordinator(s)	

Requirements:

MCQ — Release to Library: Yes ☒ No □

Handout

Statistical/ Log Tables

Cambridge Tables

Graph Paper

Log Graph Paper

Other Materials

Graphic material in colour — Yes □ No □

PTO

Q.1. (Graphics)

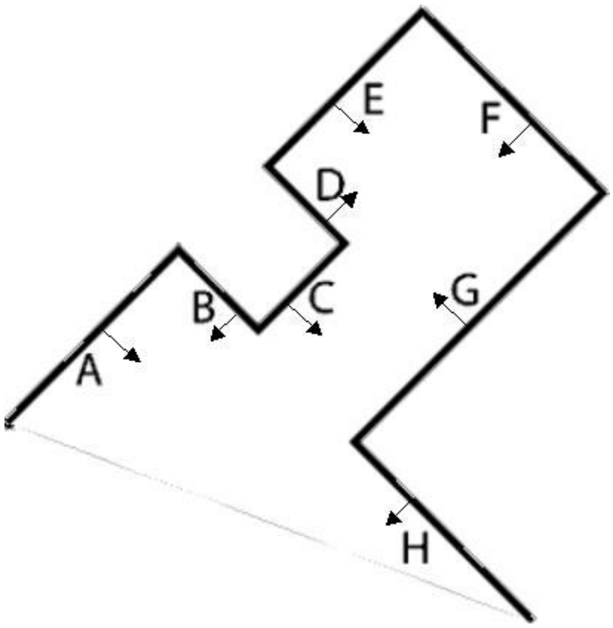
(a) Consider the display of a realistic forest in an interactive 3D graphics environment: the key trade-off is frame-rate versus polygon count. In this context, discuss the use of the following techniques in order to obtain a maximal frame-rate while rendering the trees at as high a fidelity as possible. Illustrate your answer with diagrams: [10]

(i) Textures
(ii) Visibility culling
(iii) Levels of detail (LODs)
(iv) Mipmaps
(v) Bumpmaps
(vi) Shaders

(b) The Binary Space Partitioning (BSP) algorithm is widely used in modern graphics programming.

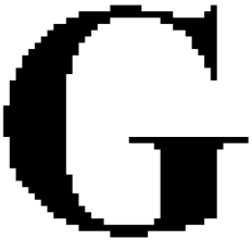
(i) Indicate a situation where the BSP approach is very useful, and another situation where it is of no use [2]

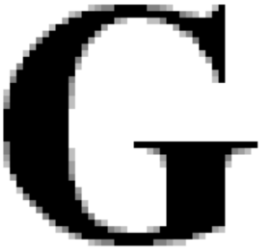
(ii) Consider the diagram below, which depicts a simple 2D scene involving 8 polygons. The polygons are labeled A through H and the arrows indicate their *surface normals*. Construct a BSP tree for this scene, and briefly explain your steps in constructing it. [8]



Q.2. (Graphics)

(a) *Antialiasing* is an approach in 2D raster graphics, which uses colour (depth) as a means to simulate an increase in resolution. With reference to the 'G' figures illustrated below, discuss the *antialisasing* technique, and in particular the concept of sub-pixel accuracy [5]

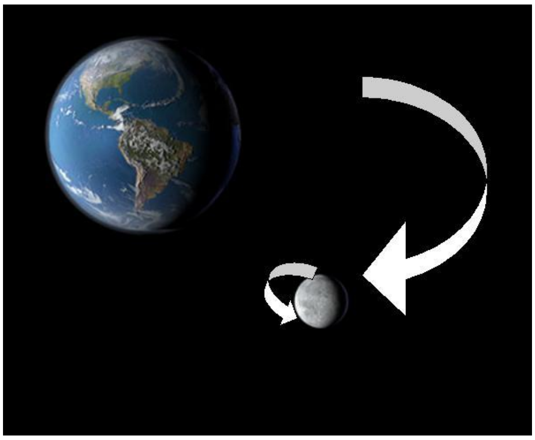




(b)

Write X3D code to produce an animation of a moon moving around a static earth. You should assume that two jpeg files "earth.jpg" and "moon.jpg" have been provided for you to texture map onto two spheres.

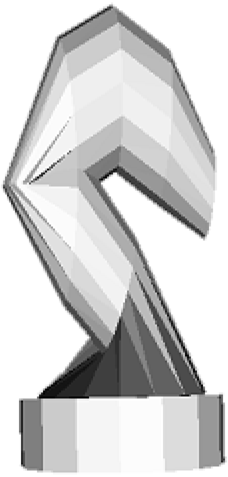
The moon should rotate on its own axis as well as around the earth. Note that some useful X3D nodes are summarised on the final page of this exam paper. [7]



(c)

Write X3D code to produce an extruded model, similar to the semi-transparent (glass) chess piece illustrated.

Note that some useful X3D nodes are summarised on the final page of this exam paper. [8]



Q.3. (Graphics)

(a) What are surface normals? Why are they essential to surface shading algorithms? Refer to Lambert Shading and Gourard Shading. Use diagrams to illustrate your answer. [8]

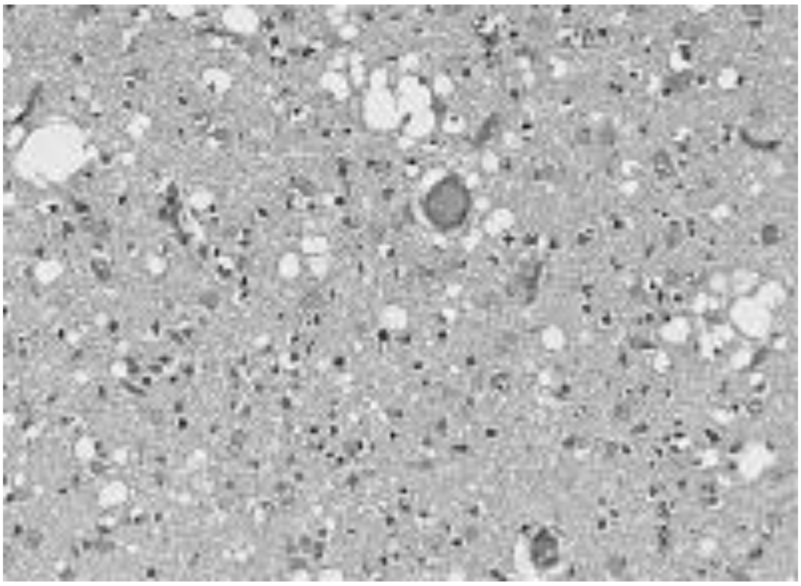
(b) Two powerful techniques for rendering shadows in realtime 3D environments are radiosity, and ambient occlusion. Explain these techniques in simple terms, drawing attention to their suitability for pre-runtime computation. [6]

(c) With respect to 3D graphics rendering, define the terms: specular colour, diffuse colour, ambient lighting. Illustrate each term with a diagram. [6]

Q.4. (Image Processing)

(a) Describe the *mathematical morphology* approach to image processing. Outline some typical circumstances in which this approach is useful [8]

(b) The image below is taken from tissue sample of a human brain affected by neurological damage. Of interest are white areas that are at least 5 pixels in diameter. **Outline** and **defend** a morphology-based algorithm for automatic isolation of areas matching this specification [12]



Q.5. (Image Processing)

(a) Many automatic image analysis algorithms begin by smoothing an image, and then applying an edge extraction filter in order to ascertain the evidence for the edges of objects in the image.

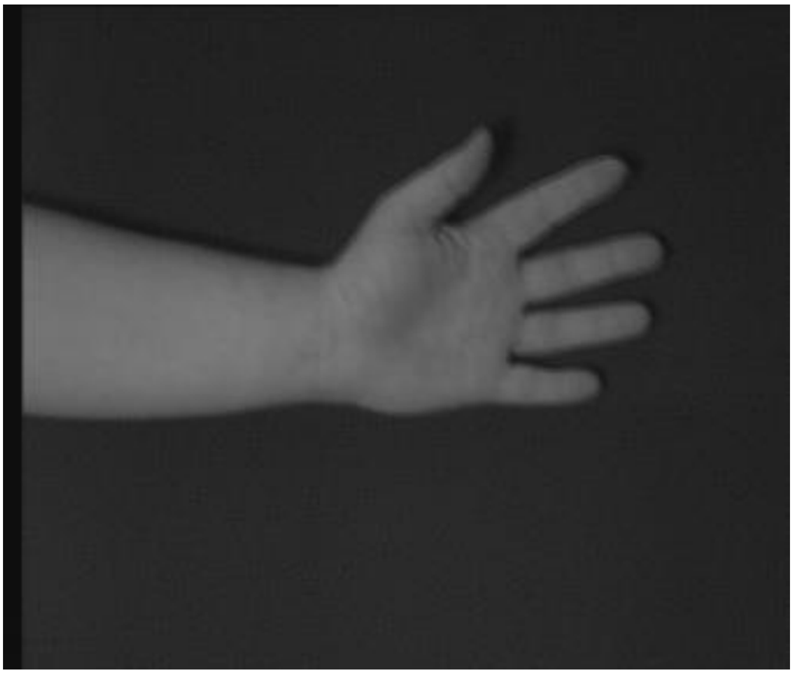
(i) Discuss the use of smoothing and edge detection for these purposes.

(ii) Discuss some approaches that might be used to deal with problems such as fragmentary edges and occluded edges. [10]

(b)

(i) Discuss the image processing technique called ‘active contours’. In your answer, explain in simple terms the algorithmic concept of optimisation.

(ii) Present a suitable set of optimisation constraints (sometimes called energy factors) for accurately tracing the outline of a hand in an image such as the one shown below, using active contours. [10]



Some useful X3D nodes:

Node	Important Fields and Nested Nodes
Shape	Nested Nodes: Appearance, Geometry Nodes (Box, Sphere, Cone, Cylinder, Text, Extrusion, etc.)
Appearance	Nested Nodes: Material, ImageTexture
Material	Fields: diffuseColor, specularColor, emissiveColor, ambientIntensity, transparency, shininess
ImageTexture	Fields: url
Transform	Fields: translation, rotation, scale, center. Nested Nodes: Other Transforms, Shapes, Sensors
TimeSensor	Fields: enabled, startTime, stopTime, cycleInterval, loop
PositionInterpolator	Fields: key, keyValue
OrientationInterpolator	Fields: key, keyValue
Extrusion	Fields: crossSection, spine, scale, orientation, beginCap, endCap, creaseAngle
Box	Fields: size
Sphere	Fields: radius
Cylinder	Fields: radius, height, side, top, bottom
Cone	Fields: height, bottomRadius, side, bottom
PointLight	Fields: on, location, radius, intensity, ambientIntensity, color, attenuation
ROUTE	Fields: fromNode, fromField, toNode, toField

Some useful methods/properties of the Canvas 2D Context object:

Method/Property	Arguments/Values	Notes
fillRect	(Left, Top, Width, Height)	Draw a filled rectangle
beginPath	None	Start a stroked path
moveTo	(X, Y)	Move the graphics cursor
lineTo	(X, Y)	Draw a line from graphics cursor
stroke	None	End a stroked path
fillStyle	="rgb(R,G,B)"	Set fill colour
strokeStyle	="rgb(R,G,B)"	Set line colour
save	None	Save the current coordinate system
restore	None	Restore the last saved coord system
translate	(X,Y)	Translate the coordinate system
rotate	(angle)	Rotate the coordinate system clockwise, with angle in radians
scale	(X,Y)	Scale the coordinate system independently on the X and Y axes